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the **Large Hadron Collider** project

LHC Project Document No.
LHC-DFBX_-ES-270.00 rev 1.0

CERN Div./Group or Supplier/Contractor Document No.
LBNL LH 20 00

EDMS Document No.

Date: 19 October 2001

Interface Specification

INNER TRIPLET FEEDBOXES: ELECTRICAL SIGNALS

Abstract

This specification establishes the detailed interface requirements of electrical signal and pressure tap connectors on the DFBX. This specification is applicable to the DFBX on both sides of the IP at points 1, 2, 5 and 8. The electrical signals pertain to inner triplet superconducting magnets and cryogenic sensors in the DFBX

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History of Changes

Rev. No.	*Date*	*Pages*	*Description of Changes*
1.0	2001-10-19		Initial submission

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1. INTRODUCTION

This specification establishes the detailed interface requirements and presents design details of electrical signal and pressure tap connectors on the DFBX. This specification is applicable to the DFBX on both sides of the IP at points 1, 2, 5 and 8. The electrical signals pertain to inner triplet superconducting magnets and cryogenic sensors in the DFBX.

2. EQUIPMENT CODES

Because each of the eight DFBX may have a unique design, the following equipment codes have been adopted facilitating a direct application of the LHC documentation system. In Table 2-1, "IRnR" signifies the right side of the Interaction Point n, and IRnL signifies the left side of Interaction Point n.

Table 2-1. DFBX Equipment Codes

Location	IR1L	IR1R	IR2L	IR2R	IR5L	IR5R	IR8L	IR8R
Code	DFBX A	DFBX B	DFBX C	DFBX D	DFBX E	DFBX F	DFBX G	DFBX H

The current lead equipment codes are given in Table 2-2.

Table 2-2. Current Lead Equipment Codes

Current Rating & Type	Equipment Code
7500 A – HTS on lower end	DFLX
600 A – Conventional Vapor Cooled	DFLY
120 A – Conventional Vapor Cooled	DFLZ

3. CO-ORDINATE SYSTEM

The local coordinate systems used in this specification are given in the DFBX General Interfaces Specification [1], and shown in Appendix A.

The origins of the DFBX local coordinate systems with respect to the CERN global coordinates are listed in Table 2-1. In deriving these locations we use the referenced CERN drawing and a flange to flange separation between the DFBX and the LQX of 510 mm [2].

Table 2-1. Position of DFBX Local Coordinate Systems

Code	Distance (mm) from IP	CERN Dwg. No.	Dwg. Ref. List
DFBXA	55052 Left of IP1	LHCLSX_0001D	[a]
DFBXB	55052 Right of IP1	LHCLSX_0002D	[b]
DFBXC	55052 Left of IP2	LHCLSX_0003D	[c]
DFBXD	55052 Right of IP2	LHCLSX_0004D	[d]
DFBXE	55052 Left of IP5	LHCLSX_0009D	[e]
DFBXF	55052 Right of IP5	LHCLSX_0010D	[f]
DFBXG	55052 Left of IP8	LHCLSX_0015D	[g]
DFBXH	55052 Right of IP8	LHCLSX_0016D	[h]

4. ELECTRICAL FEEDTHROUGHS

4.1 IP1 AND IP5

At these points, the DFBX provides signal connectors from:

- the inner triplets (LQX),
- 2 pair of 7500 A current leads with HTS lower sections (DFLX),
- 7 pair of 600 A vapor-cooled current leads (DFLY),
- 5 pair of 120 A vapor-cooled current leads (DFLZ), and
- cryogenic sensors in the DFBX.

4.1.1 LQX SIGNAL RECEPTACLES

The electrical signal and heater wires from the inner triplet superconducting quadrupoles are terminated in the LQX Feedthrough Assembly shown in Figure 4.1.1-1, taken from LBNL Drawing 25I831. The connection at CERN is made by plugging into the four receptacles in Item 6 and the single receptacle in Item 7. The signal wires from the LQX are contained in a single tube designated as MQX2 in the DFBX [2] that satisfies the packing fraction constraints of [3]. This tube leads into the feedthrough assembly shown in Figure 4.1.1-1which is located on the top plate of the DFBX as shown in Figures 4.1.1-2 and 4.1.1-3.

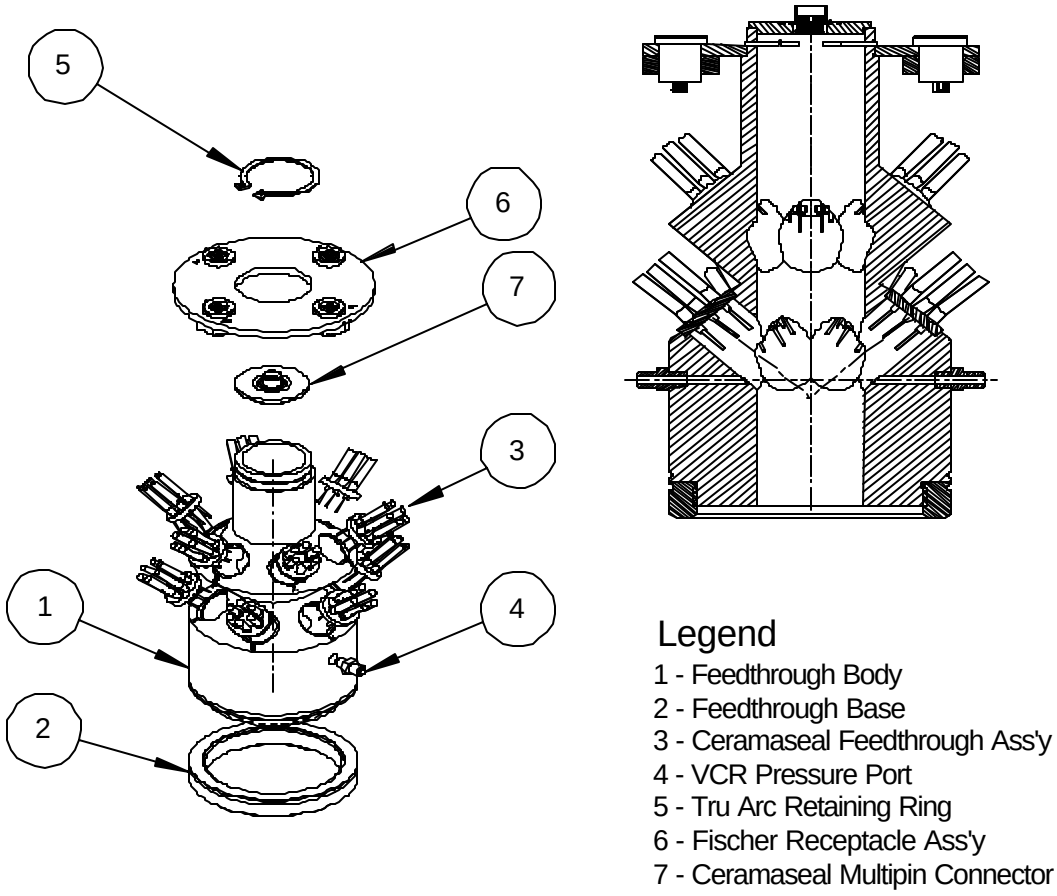


Figure 4.1.1-1. Cross Sectional view of the LQX feedthrough assembly

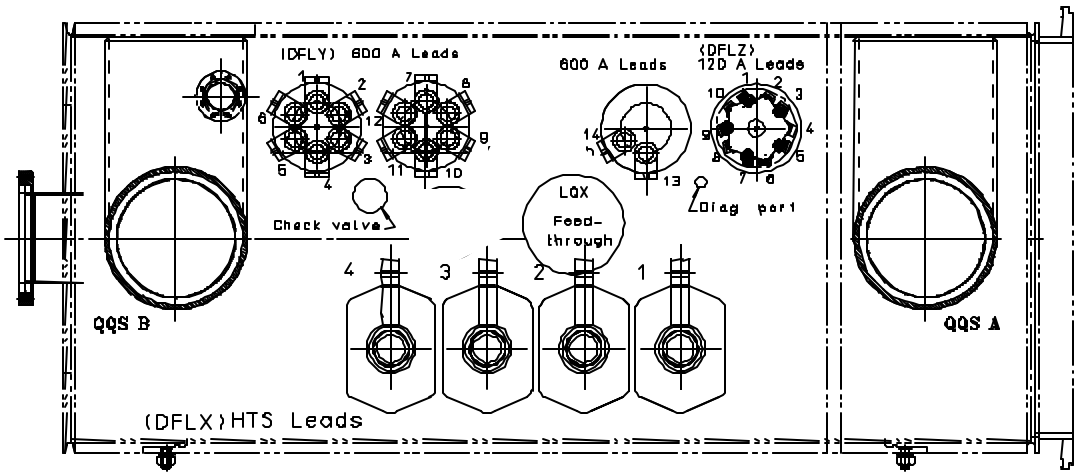


Figure 4.1.1-2. Location of LQX feedthrough assembly for DFBXA and DFBXE. The assembly is located at y = -1150.

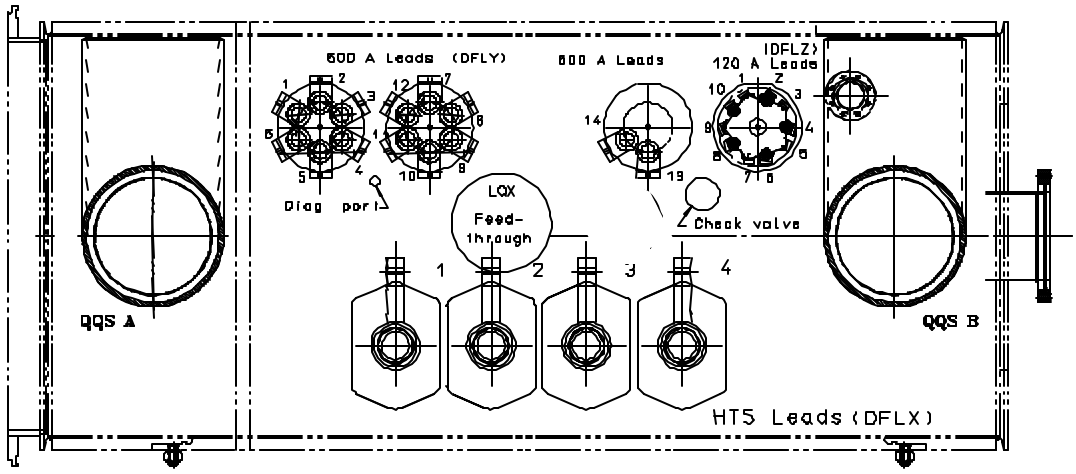


Figure 4.1.1-3. Location of LQX feedthrough assembly for DFBXB and DFBXF. The assembly is located at y = +1150.

The LQX Feedthrough assembly body, Item 1 in Fig 4.1.1-1, contains individual feedthroughs for voltage taps and heaters and a 32-pin receptacle for magnet thermometer wires. The feedthroughs and receptacle are welded to the housing.

The individual feedthroughs are Ceramaseal P/N 4275-21-W which have a 12 kV voltage rating and an internal pressure rating of 68 bar.

The individual Ceramaseal feedthroughs are arranged in arrays of 6, as shown in Figure 4.1.1-4. The assembly in Figure 4.1.1-1 contains a total of 12 arrays for a total of 72 available feedthroughs. The arrays are arranged in two staggered tiers; each tier contains 6 arrays.

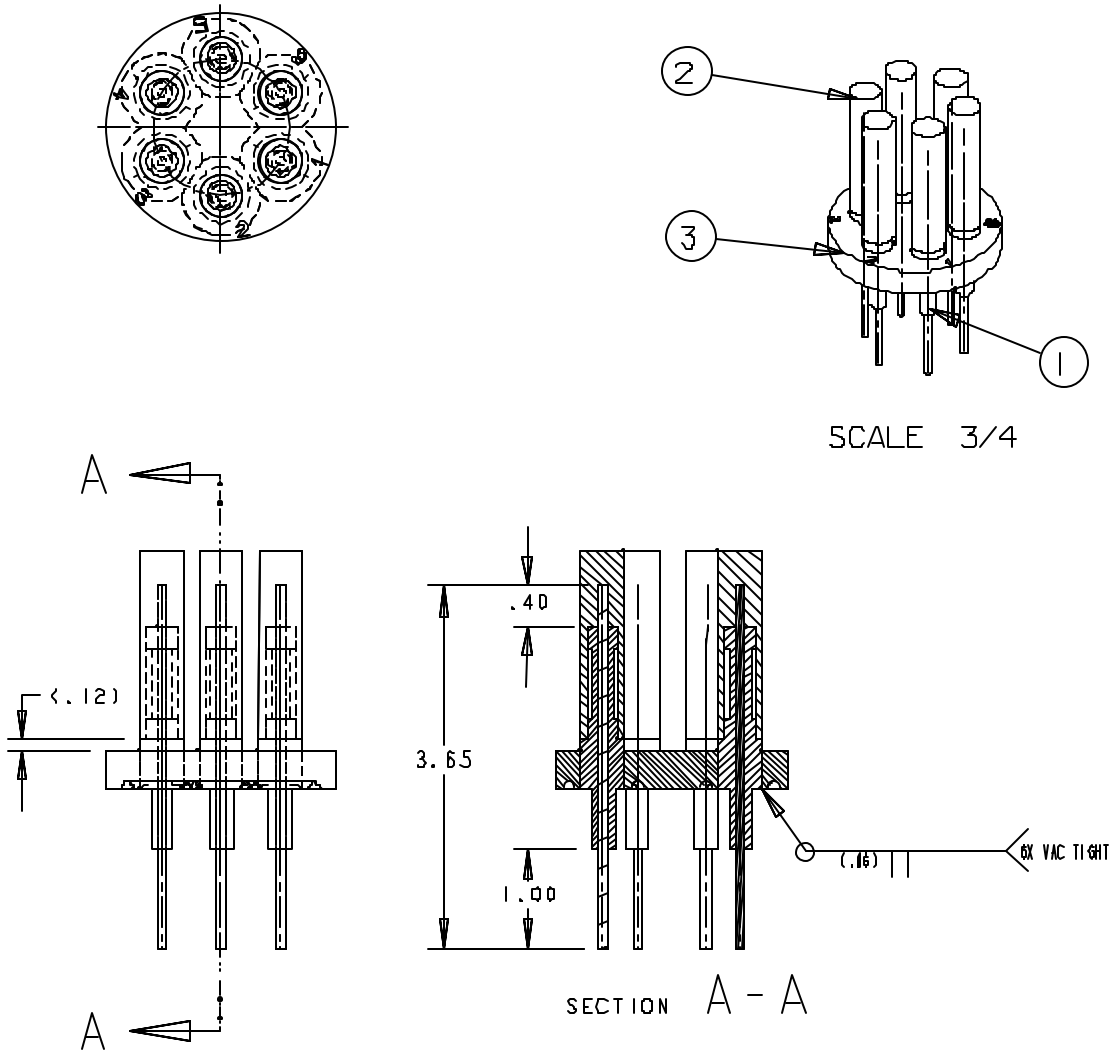


Figure 4.1.1-4. LQX high voltage feedthrough array.

Each feedthrough in the LQX assembly is uniquely identified by an alphanumeric designator. The array position is denoted by a letter (A-L) which is permanently

marked on the housing, and each feedthough position is the array is denoted by a number (1-6) which is permanently marked on the array.

The individual feedthroughs are connected to one of four 40-pin Fischer receptacles of type DEE 107 A052 (in item 6 of Fig 4.1.1-1) by a wiring harness with plugs (item 2 in Fig 4.1.1-4) that mate to the individual Ceramaseal feedthroughs. The 40-pin receptacles have PEEK insulator blocks.

The thermometer wires are terminated in a Ceramaseal Receptacle P/N 16014-02-W. This receptacle has 32 pins with a voltage rating of 1 kV pin to pin and pin to body. The pressure rating is 500 psi (34 bar). An air-side plug, Ceramaseal P/N 16060-05-A is provided for connection to the LHC control system. For the voltage rating of the sensors, see [2].

In addition to the electrical feedthroughs, the assembly contains two mechanical ports with male VCR-style Cajon connectors, P/N SS-8-VCR-1-6, that can be used as pressure taps for the LQX cold mass via the void fraction of the MQX2 tube.

The sections below present the details of the individual connectors.

4.1.1.1 LQX VOLTAGE TAPS

The LQX voltage taps include 24 voltage taps on the Q1 –Q3 coils (designated here as Vn) and 12 voltage taps on the corrector magnets (designated here as Cn) [2]. These wires are individually soldered to the Ceramaseal feedthroughs, P/N 4275-21-W. The connection is potted with de-aired Stycast 2850MT (blue) epoxy on the helium side to provide voltage holding capability and strain relief for the wires. Air-side plugs, Ceramaseal P/N 14419-01-A, are used to connect the individual feedthroughs to the 40-pin Fischer receptacles labeled as PG1 and PG2, for connection to the LHC control system. Tables 4.1.1.1-1 and 4.1.1.1-2 give the correspondence between magnet voltage tap, feedthrough number, and Fischer pin.

Table 4.1.1.1-1. Connection Map of Main Magnet Voltage Tap Signals

LQX Signal Wire	Feedthrough Number	Plug 1 Pin Number	LQX Signal Wire	Feedthrough Number	Plug 1 Pin Number
V1	A-1	1	V13	C-1	13
V2	A-2	2	V14	C-2	14
V3	A-3	3	V15	C-3	15
V4	A-4	4	V16	C-4	16
V5	A-5	5	V17	C-5	17
V6	A-6	6	V18	C-6	18
V7	B-1	7	V19	D-1	19
V8	B-2	8	V20	D-2	20
V9	B-3	9	V21	D-3	21
V10	B-4	10	V22	D-4	22
V11	B-5	11	V23	D-5	23
V12	B-6	12	V24	D-6	24

Table 4.1.1.1-2. Connection Map of Corrector Magnet Voltage Tap Signals

LQX Signal Wire	Feedthrough Number	Plug 2 Pin Number
C1	E-1	1
C 2	E-2	2
C3	E-3	3
C4	E-4	4
C5	E-5	5
C6	E-6	6
C7	F-1	7
C8	F-2	8
C9	F-3	9
C10	F-4	10
C11	F-5	11
C12	F-6	12

4.1.1.2 LQX HEATERS

The LQX quench protection and cryogenics system balancing heater wires are terminated in a similar manner as the voltage taps in 4.1.1.1 above to Fischer 40-pin receptacles PG3 and PG4. There are 16 wires for quench protection heaters (designated here as Hn) and 16 wires for cryogenics system balancing heaters (designated here as Wn) [2]. The individual feedthroughs have a current rating of 30 A, which is more than sufficient to power the heaters. The gauge of the heater wires is given in [2]. Table 4.1.1.2-1 gives the pin locations of the LQX heaters.

Table 4.1.1.2-1. Connection Map of LQX Heater Wires

Heater Lead	Feedthrough Number	Plug 3 Pin Number	Heater Lead	Feedthrough Number[a]	Plug 4 Pin Number
H1+	G-1	1	W1+	I-5	1
H1-	G-2	2	W1-	I-6	2
H2+	G-3	3	W2+	J-1	3
H2-	G-4	4	W2-	J-2	4
H3+	G-5	5	W3+	J-3	5
H3-	G-6	6	W3-	J-4	6
H4+	H-1	7	W4+	J-5	7
H4-	H-2	8	W4-	J-6	8
H5+	H-3	9	W5+	K-1	9
H5-	H-4	10	W5-	K-2	10
H6+	H-5	11	W6+	K-3	11
H6-	H-6	12	W6-	K-4	12
H7+	I-1	13	W7+	K-5	13
H7-	I-2	14	W7-	K-6	14
H8+	I-3	15	W8+	L-1	15
H8-	I-4	16	W8-	L-2	16

a. Feedthroughs L-3 through L-6 are not connected.

4.1.1.3 LQX THERMOMETERS

The LQX cold mass contains 8 thermometers [2], which require 32 wires. These wires are terminated in a 32-pin Ceramaseal receptacle P/N 16014-02-W, item 7 on Figure 4.1.1-1. The receptacle has a solder cup on the helium side into which the wires are soldered. After soldering, the wires will be potted with de-aired Stycast 2850MT (blue) epoxy into the connector to provide additional voltage withstand capability and to provide strain relief. The receptacle pin connections are given in Table 4.1.1.3-1. An air-side plug, Ceramaseal P/N 16060-05-A with crimp-type contacts is provided for connection to the CERN system.

Table 4.1.1.3-1. LQX thermometer receptacle pin designations.

Thermometer	V+	V-	I+	I-
T1	1	2	3	4
T2	5	6	7	8
T3	9	10	11	12
T4	13	14	15	16
T5	17	18	19	20
T6	21	22	23	24
T7	25	26	27	28
T8	29	30	31	32

4.1.1.4 PRESSURE PORTS

The VCR-style pressure ports, item 4 in Fig 4.1.1-1, provide CERN a means of monitoring the pressure in the inner triplet cold mass.

4.1.2 DFLX SIGNALS

The current leads designated as DFLX have a rating of 7500 A and use high temperature superconductor in the lower section to reduce the cryogenic heat load of the DFBX. The current leads are produced by Pirelli (formerly BICC) per LBNL specification M923B [4] and contain voltage taps and thermometers as shown in Figure 4.1.2-1. The physical location of the DFLX can be found in [5].

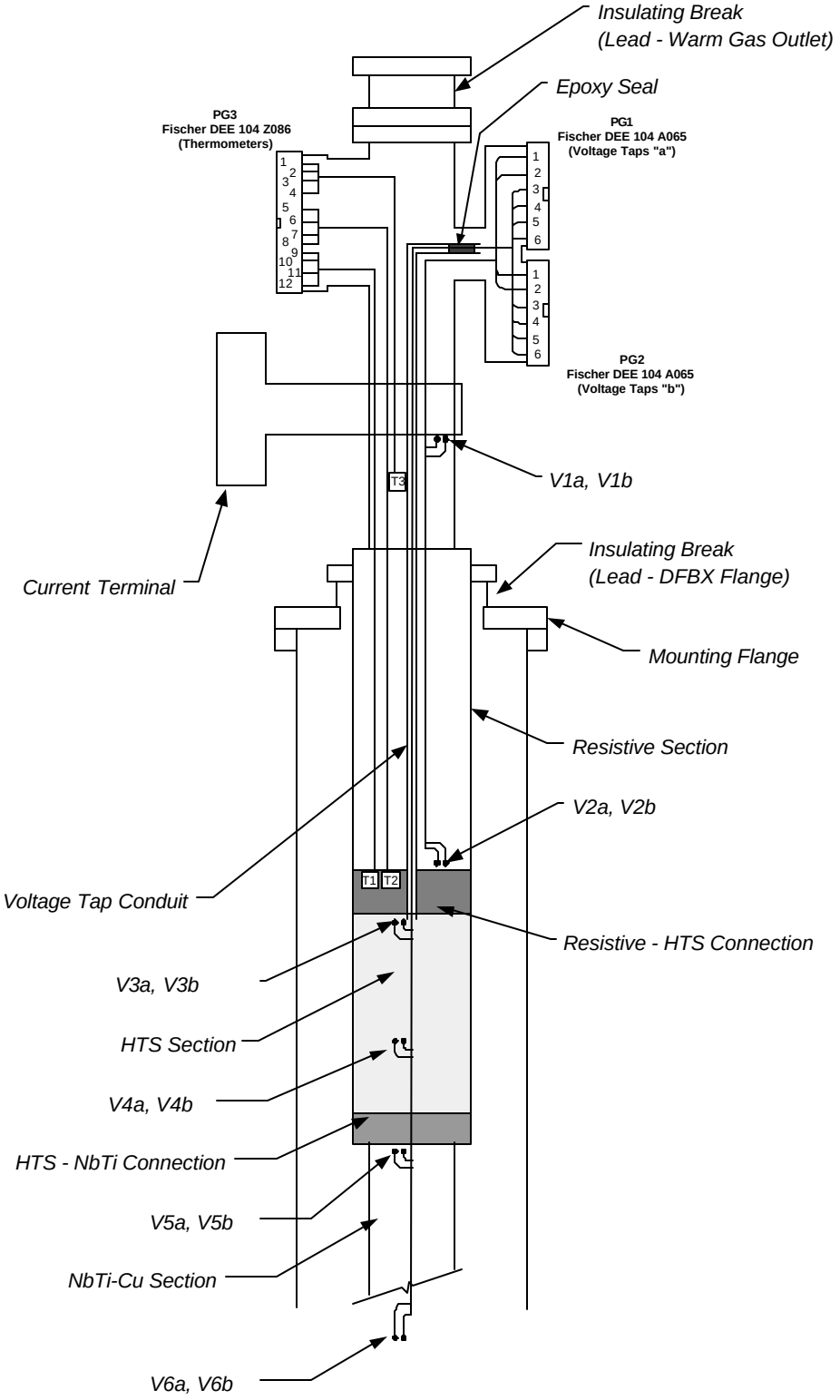


Figure 4.1.2-1. DFLX Instrumentation Schematic (from LBNL Spec M923A).

The physical location of the connectors is shown on Figure 4.1.2-2. The DFLX will be oriented with the signal receptacles along the aisle side of the DFBX. The receptacles will be tilted 10? from the vertical towards the aisle.

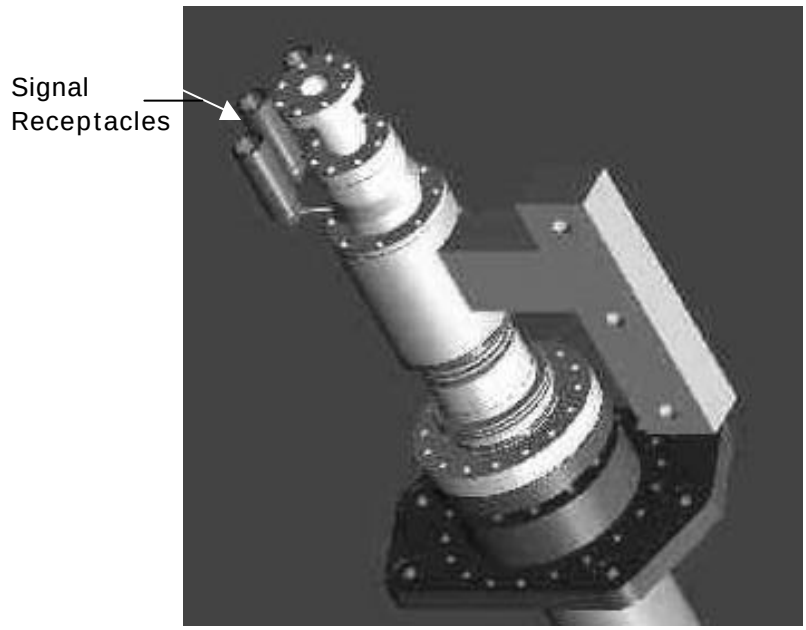


Figure 4.1.2-2. Location of signal receptacles on DFLX Lead (from Pirelli).

4.1.2.1 DFLX VOLTAGE TAPS

The DFLX voltage taps terminate in a pair of 6-pin Fischer DEE A 104 A065 receptacles, with PEEK insulators. The wires on the helium side are potted to ensure voltage capability and provide strain relief. The pin designations for the two receptacles are given in Table 4.1.2.1-1.

Table 4.1.2.1-1. DFLX Voltage Taps

Pin	Receptacle 1	Receptacle 2
1	V1a	V1b
2	V2a	V2b
3	V3a	V3b
4	V4a	V4b
5	V5a	V5b
6	V6a	V6b

4.1.2.2 DFLX THERMOMETERS

Each DFLX current lead contains three class A Platinum resistance thermometers with the European coefficient (Pt100 IEC) as shown on Figure 4.1.2-1. As a minimum, T2 will be removable. The thermometers are connected in a 4-wire arrangement so a total of 12 pins are needed. The wires are terminated in a single 16-pin Fischer

receptacle, DEE 104 Z086, according to the arrangement in Table 4.1.2.2-1. The receptacle has a PEEK insulator block. After soldering, the wires on the helium side are potted to ensure voltage capability and to provide strain relief. According to [4], the thermometers shall withstand 300 V dc with respect to the current lead.

Table 4.1.2.2-1. DFLX thermometer receptacle pin designations.

Thermometer	V+	V-	I+	I-
T1	1	2	3	4
T2	5	6	7	8
T3	9	10	11	12

4.1.3 DFLY VOLTAGE TAPS

The current leads designated as DFLY are conventional 600 A vapor-cooled current leads and are used to power certain corrector magnets. A total of 7 pair of DFLY are installed in each DFBX. Two types of DFLY assemblies are used to fill the DFBX, one with 3 pairs of leads and the other with a single pair. The DFLY physical location and arrangement is given in [5].

The only diagnostics supplied with the DFLY are voltage taps, which are connected as shown on Figure 4.1.3-1 for the two types of assemblies. Each individual current lead has 3 voltage taps: V1 on the warm terminal, V2 on the bottom of the heat exchanger section, and V3 on the superconducting bus below the connection to the lead.

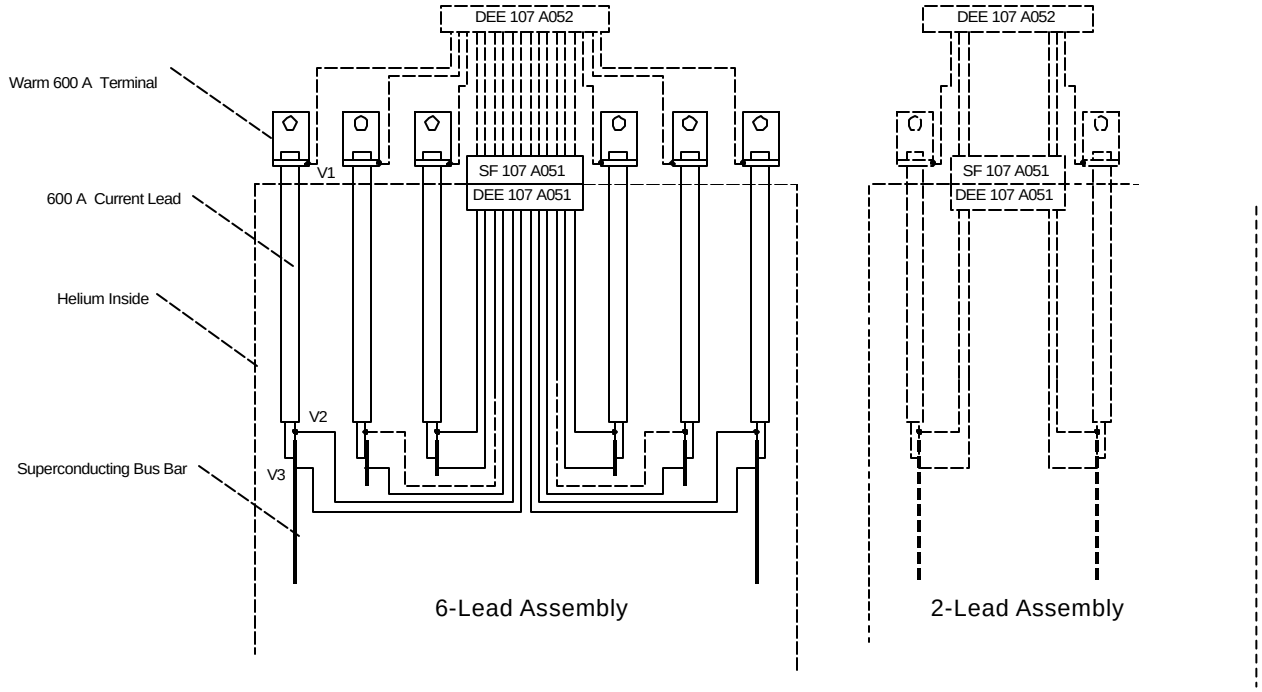


Figure 4.1.3-1. DFLY voltage tap schematics.

A drawing of the DFLY voltage tap feedthrough for the 3 pair assembly is shown on Figure 4.1.3-2. The arrangement fits snugly inside the circular array of current leads. The feedthrough is the same for the 1 pair assembly.

The voltage taps inside the helium chamber are connected to a 27 pin Fischer receptacle, P/N DEE 107 A051. This receptacle has a voltage rating of 3 kV pin to body and 3.2 kV pin to pin, a PEEK insulator, and has an internal pressure rating of 8 bar. The wires are soldered into the contacts and are potted with de-aired Stycast 2850MT (blue) epoxy to provide suitable voltage capability and strain relief. A mating Fischer SF 107 A051 plug provides room temperature access to the signals from the helium chamber.

The voltage taps from the warm terminals together with the wires from the SF 107 A051 plug are soldered into the upper 40 pin Fischer DEE 107 A052 receptacle for convenient connection to the LHC control system via a Fischer S 107 A052 plug (not shown).The Fischer receptacle DEE 107 A052 has a PEEK insulator and has a voltage rating of 2.5 kV pin to body and 2 kV pin to pin.

The wiring will have sufficient slack to allow the receptacles to be replaced without removing the current lead assembly from the DFBX.

Table 4.1.3-1 gives the correspondence between voltage tap and CERN plug pin number for each assembly. See [5] for the correspondence between DFLY and the corrector magnet.

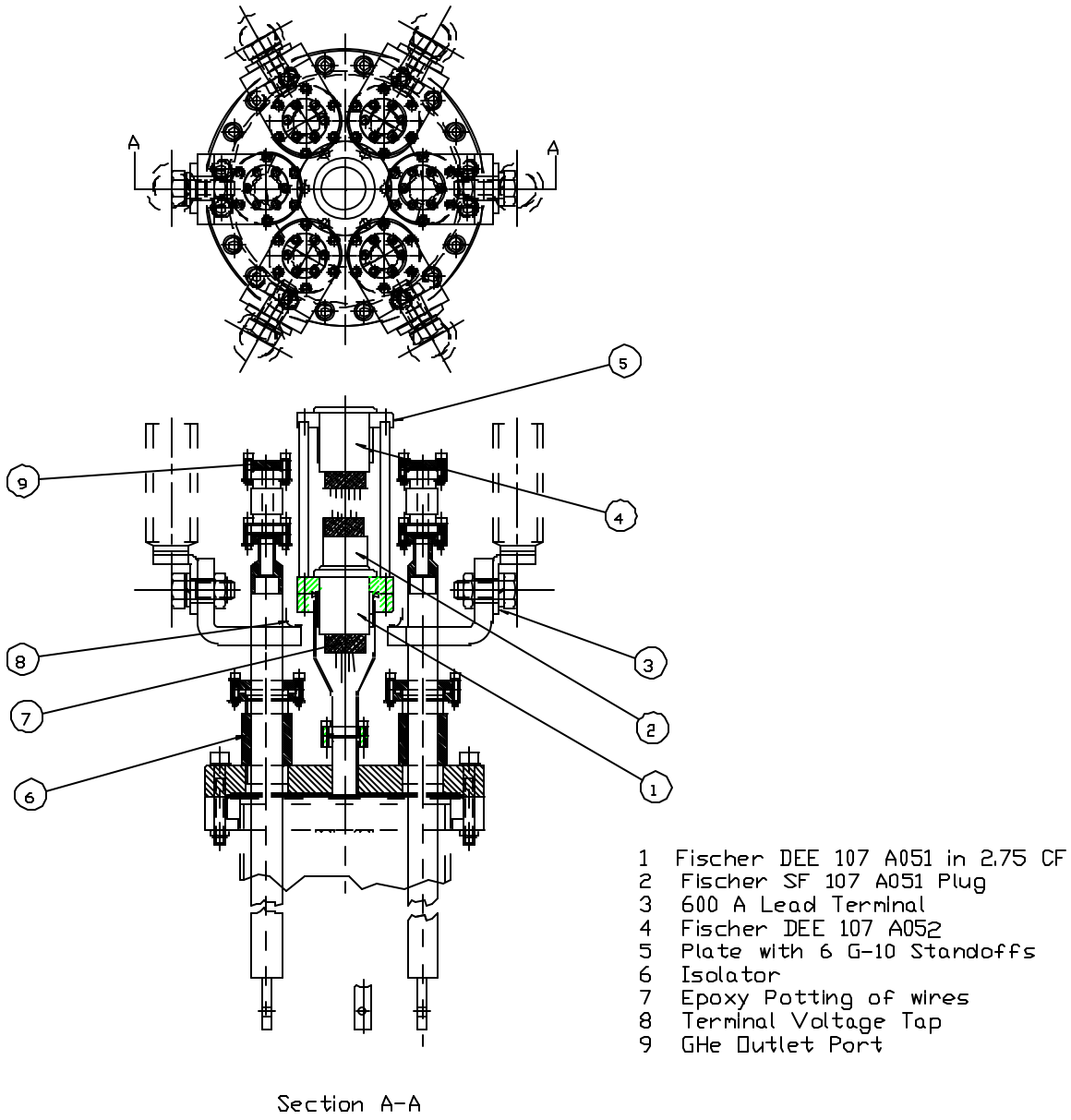


Figure 4.1.3-2. DFLY voltage tap feedthrough.

Table 4.1.3-1. Correspondence between DFLY voltage tap and CERN Pin

Assembly	DFLY No.	Voltage Tap	Pin No.
1	1	V1	3
		V2	4
		V3	5
	2	V1	6
		V2	7
		V3	8
	3	V1	9
		V2	10
		V3	27
	4	V1	28
		V2	29
		V3	30
	5	V1	31
		V2	32
		V3	33
	6	V1	34
		V2	35
		V3	36
2	7	V1	3
		V2	4
		V3	5
	8	V1	6
		V2	7
		V3	8
	9	V1	9
		V2	10
		V3	27
	10	V1	28
		V2	29
		V3	30
	11	V1	31
		V2	32
		V3	33
	12	V1	34
		V2	35
		V3	36
3	13	V1	3
		V2	4
		V3	5
	14	V1	6
		V2	7
		V3	8

4.1.4 DFLZ VOLTAGE TAPS

The current leads designated as DFLZ are conventional 120 A vapor-cooled current leads used to power certain multipole corrector magnets. A total of 5 pair (10 total) DFLZ are installed as a single assembly in each DFBX.

The only diagnostics supplied with the DFLZ are voltage taps, which are connected as shown on Figure 4.1.4-1. Each individual current lead has 3 voltage taps: V1 on the warm terminal, V2 on the bottom of the heat exchanger section, and V3 on the superconducting bus below the connection to the lead.

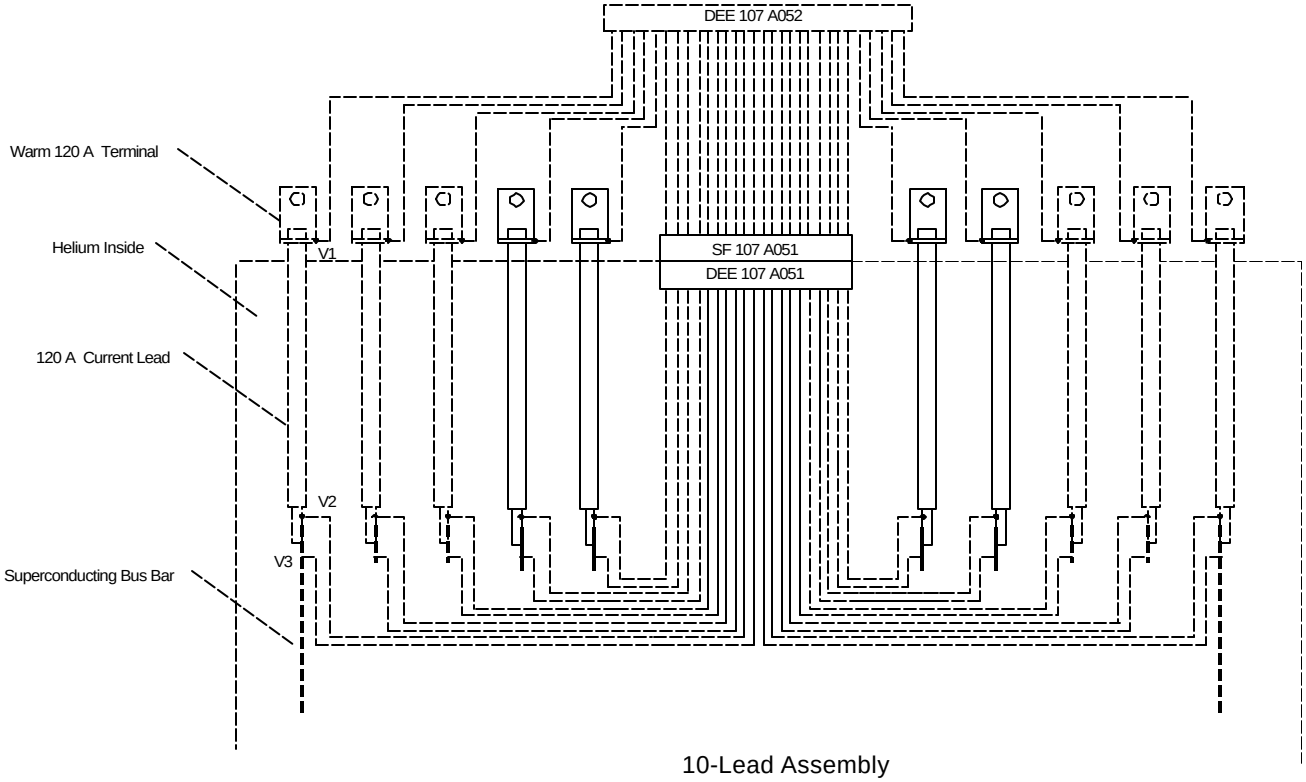


Figure 4.1.4-1. DFLZ Voltage tap schematic.

A drawing of the DFLZ voltage tap feedthrough is shown on Figure 4.1.4-2. The arrangement fits snugly inside the circular array of current leads.

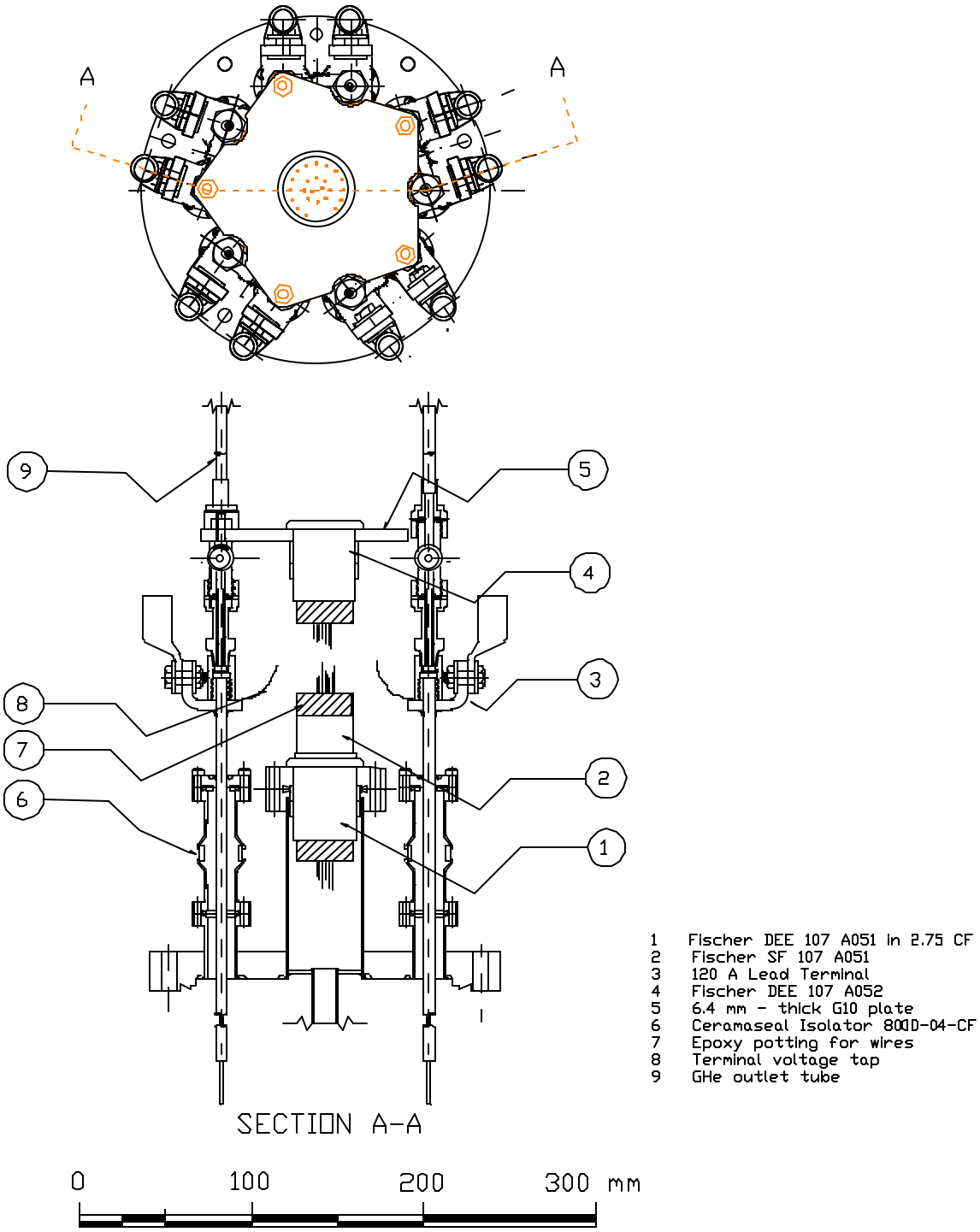
The voltage taps inside the helium chamber are connected to a 27 pin Fischer receptacle, P/N DEE 107 A051. This receptacle has a voltage rating of 3 kV pin to body and 3.2 kV pin to pin, a PEEK insulator, and has an internal pressure rating of 8 bar. The wires are soldered into the contacts and are potted with de-aired Stycast 2850MT (blue) epoxy to provide suitable voltage capability and strain relief. A mating Fischer SF 107 A051 plug provides room temperature access to the signals from the helium chamber.

The voltage taps from the warm terminals together with the wires from the SF plug are soldered into the 40 pin Fischer receptacle P/N DEE 107 A052 for convenient connection to the LHC control system via a Fischer S 107 A052 plug (not shown). The

Fischer receptacle DEE 107 A052 has a PEEK insulator and a voltage rating of 2.5 kV pin to body and 2 kV pin to pin.

The wiring will have sufficient slack to allow the receptacles to be replaced without removing the current lead assembly from the DFBX.

Table 4.1.4-1 gives the correspondence between DFLZ voltage tap and CERN plug pin. See [5] for the correspondence between DFLZ and the corrector magnet.



1 Fischer DEE 107 A051 in 2.75 CF
2 Fischer SF 107 A051
3 120 A Lead Terminal
4 Fischer DEE 107 A052
5 6.4 mm - thick G10 plate
6 Ceramaseal Isolator 8001D-04-CF
7 Epoxy potting for wires
8 Terminal voltage tap
9 GHe outlet tube

Figure 4.1.4-2. DFLZ Voltage Tap Feedthrough.

Table 4.1.4-1. Correspondence between DFLZ voltage tap and CERN Pin

DFLZ No.	Voltage Tap	Pin No.
1	V1	11
	V2	12
	V3	13
2	V1	14
	V2	15
	V3	16
3	V1	17
	V2	18
	V3	19
4	V1	20
	V2	21
	V3	22
5	V1	23
	V2	24
	V3	25
6	V1	26
	V2	27
	V3	28
7	V1	29
	V2	30
	V3	31
8	V1	32
	V2	33
	V3	34
9	V1	35
	V2	36
	V3	37
10	V1	38
	V2	39
	V3	40

4.1.5 DFBX SIGNALS

The signals from the DFBX emanate from two different locations. The first is from the inside of the liquid helium chamber, and the second is from sensors on the cryogenic piping in the insulating vacuum space.

4.1.5.1 LIQUID HELIUM CHAMBER SIGNALS

The DFBX current lead chamber will be equipped with 2 redundant liquid helium level sensors, a Pt RTD for cooldown monitoring, and two redundant 200 W heaters for liquid level control. These elements will be removable. The liquid helium level must be maintained within ? 10 mm of the desired setpoint for proper operation of the High Temperature Superconductor section of the DFLX current leads.

These devices are connected to a Fischer DEE 104 Z086 receptacle, mounted on top of the Lead Chamber Service Port. The Service Port is located on the DFBX top plate as shown in Figure 4.1.5.1-1. In addition to the electrical connectors, the service port

contains two mechanical ports with male VCR-style Cajon connectors that can be used as pressure taps for the liquid helium chamber. Table 4.1.5.1-1 gives the pin designations of the receptacle.

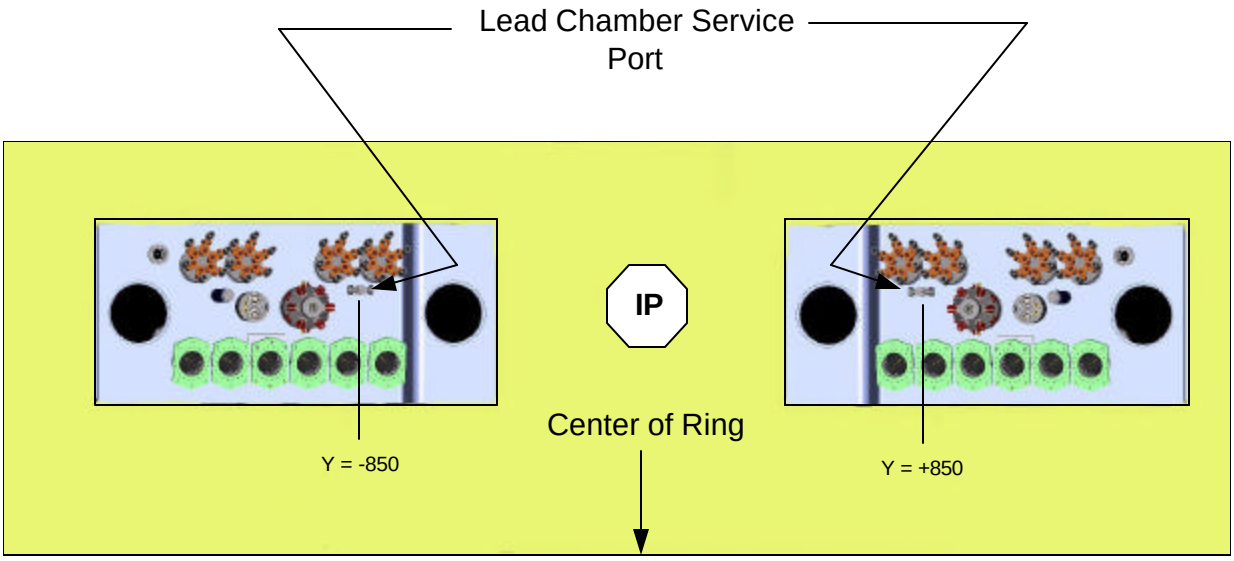


Figure 4.1.5.1-1. Position of Lead Chamber Signal Feedthrough on Top Plate.

Note: Points 2 & 8 shown, with many DFBX features eliminated for clarity. Y locations for points 1 and 5 are same as shown.

Table 4.1.5.1-1. DFBX Lead Chamber receptacle pin designations.

Device	V+	V-	I+	I-
Level Sensor 1	1	2	3	4
Level Sensor 2	5	6	7	8
Pt RTD	9	10	11	12
Heater 1			13	14
Heater 2			15	16

4.1.5.2 CRYOGENIC PIPING SIGNALS

A limited number of temperature sensors and heaters will be installed on the DFBX cryogenic piping to determine cryogenic performance, The wires from these devices will be connected to a 32 pin receptacle, Ceramaseal P/N 16014-02-W, mounted on the vacuum pumpout and relief port as shown in Figure 4.1.5.2-1. This is positioned on the DFBX top plate as shown on Figure 4.1.5.2-2. Further details on the sensors and their connection will be determined and listed in a later revision of this document.

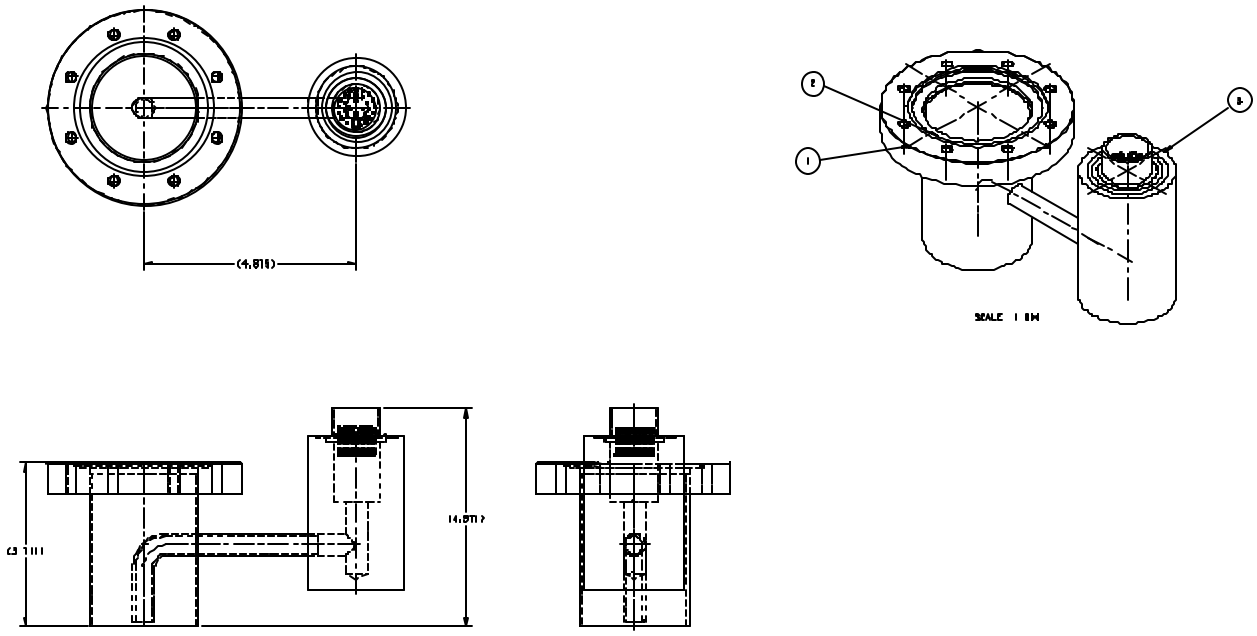


Figure 4.1.5.2-1. Details of signal connector on vacuum port.

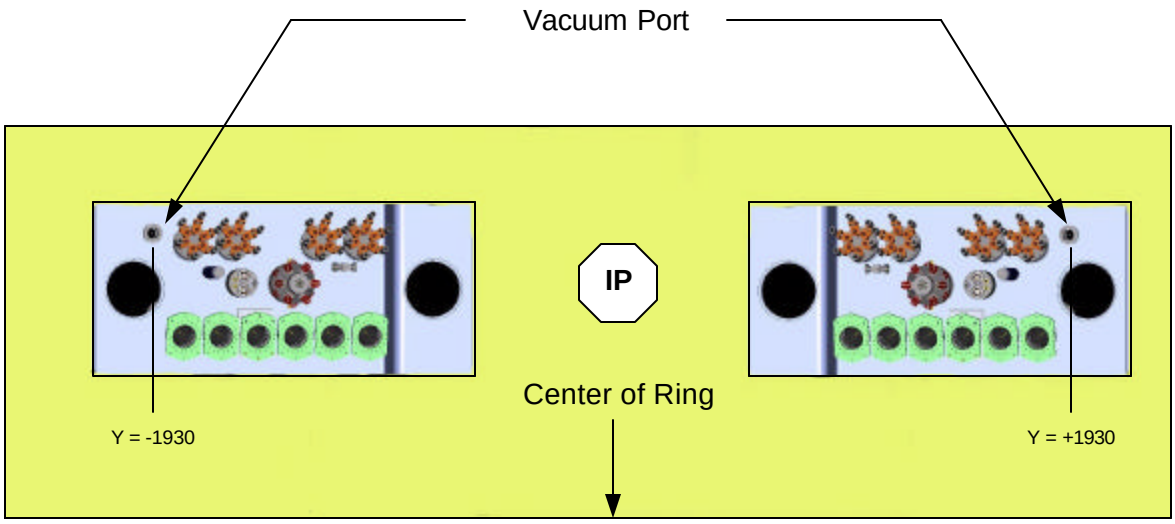


Figure 4.1.5.2-2. Position of signal connector on DFBX Top Plate.

Note: Points 2 & 8 shown, with many DFBX features eliminated for clarity. Y locations for points 1 and 5 are same as shown.

4.1.5.3 1.9K OVERFLOW CHAMBER SIGNALS

The 1.9 K overflow chambers are passively heated so no active sensors and heaters are needed. However, provision is made for a pressure tap for CERN's use. The pressure tap access is surrounded by a helium guard volume. Items 17 and 14 on

Figures 4.1.5.3-1 and 4.1.5.3-2 show the location of the 100 mm Conflat Flange and tube that form the base of the guard volume on the top plate for DFBXA (IP1L) and DFBXF (IP5R), respectively.

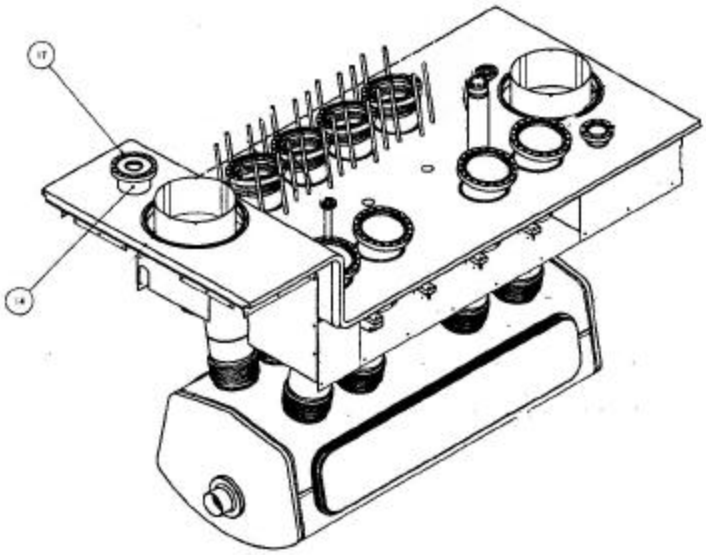


Figure 4.1.5.3-1. DFBXA Top Plate Assembly. Items 14 and 17 form the base of the helium guard volume.

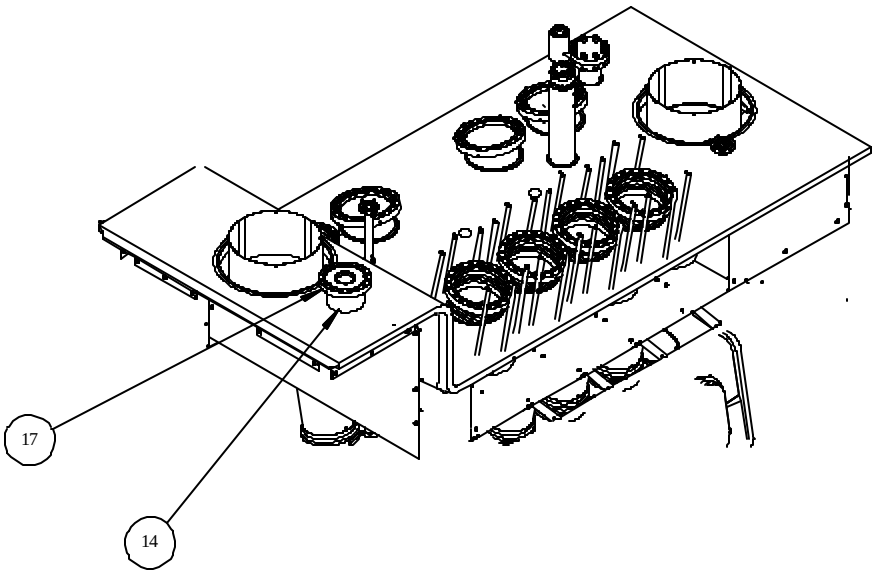


Figure 4.1.5.3-2. DFBXF Top Plate Assembly. Items 14 and 17 form the base of the helium guard volume.

Fig 4.1.5.3-3 shows the details of the pressure tap and helium guard volume. The 3 mm diameter instrumentation tube from the overflow pot passes through a welded

fitting, item 5, and is terminated in a VCR gland, item 6. The CERN manometer is connected to the VCR gland, and its wires are connected to the welded multipin connector, item 2. After the chamber, item 4, is sealed the volume can be evacuated and backfilled with helium gas through the VCR port, item 3.

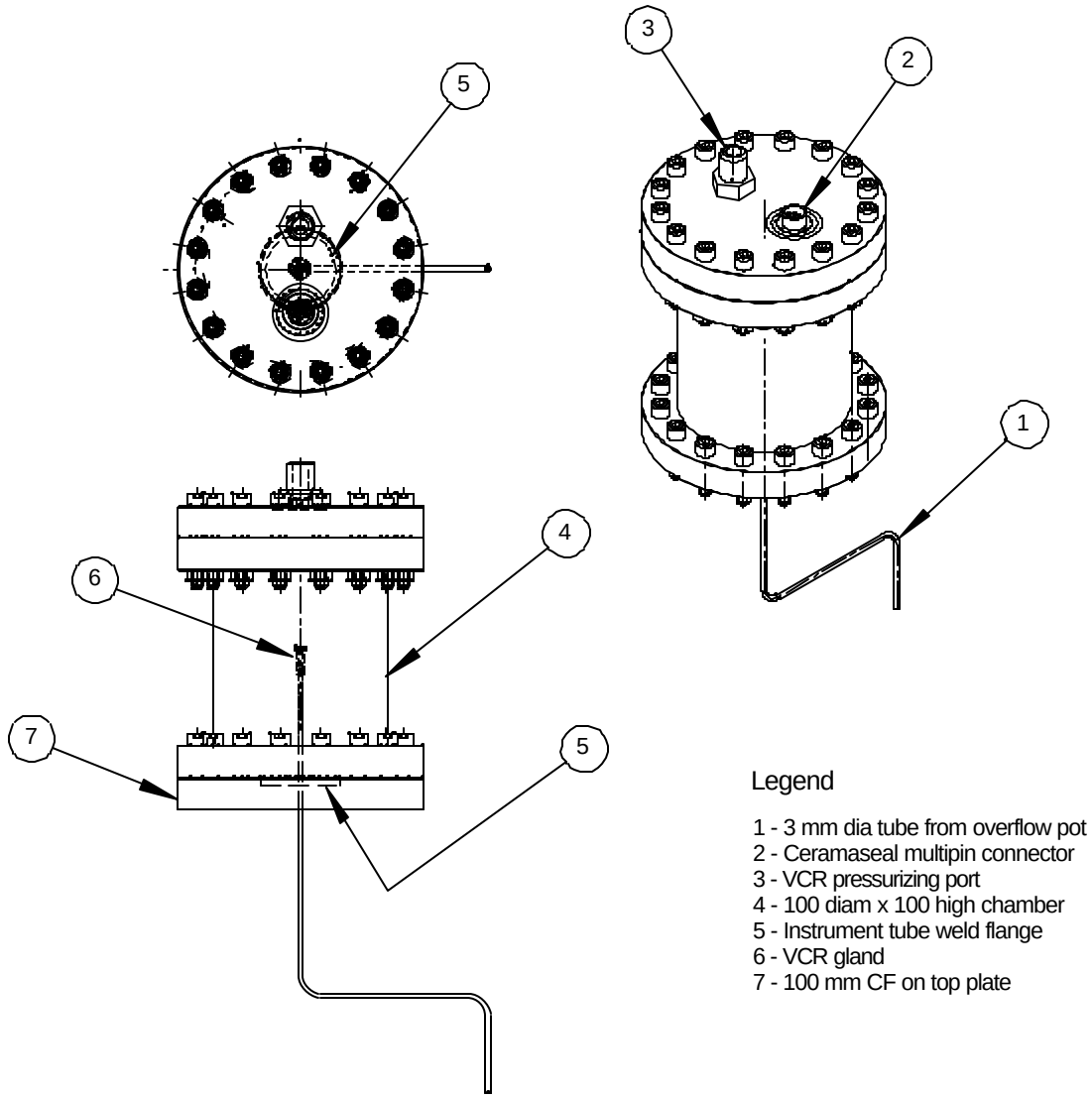


Figure 4.1.3.5-3. Details of Pressure Tap and Helium Guard Volume.

4.2 IP2 AND IP8

The DFBX at points 2 and 8 include the signal connectors as itemized in 4.1 above, plus signals from the superconducting D1 (LBX) and one additional pair of 7500 A current leads with HTS lower sections (DFLX).

4.2.1 LQX SIGNALS

The connectors are identical to those in section 4.1.1 above.

4.2.1.1 LQX VOLTAGE TAPS

The connectors are identical to those in section 4.1.1.1 above.

4.2.1.2 LQX HEATERS

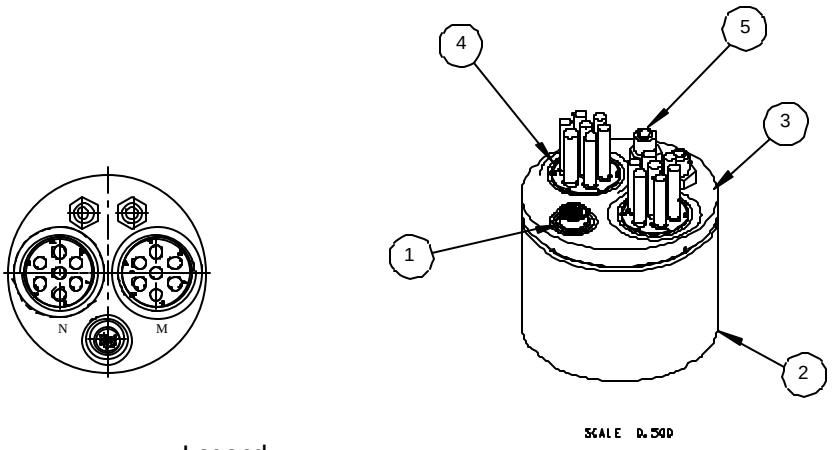
The connectors are identical to those in section 4.1.1.2 above.

4.2.1.3 LQX THERMOMETERS

The connectors are identical to those in section 4.1.1.3 above.

4.2.2 LBX SIGNALS

The electrical signals from the superconducting D1 magnets are contained in a single tube in the DFBX that satisfies the packing fraction constraints of [3]. This tube, designated as MBX2 in [6], leads into the feedthrough assenbly shown in Figure 4.2.2-1. This assembly is positioned on the DFBX top plate as shown in Figures 4.2.2-2 and 4.2.2-3. The assembly contains individual feedthroughs for voltage taps and heaters and a 19-pin receptacle for magnet thermometers and level indicators.



Legend

1 - Ceramaseal Multipin Connector
2 - LBX Feedthrough Base
3 - LBX Feedthrough Top
4 - Ceramaseal Feedthrough Ass'y, 7-pin
5 - VCR Pressure Port

Figure 4.2.2-1. LBX Instrumentation Feedthrough Assembly.

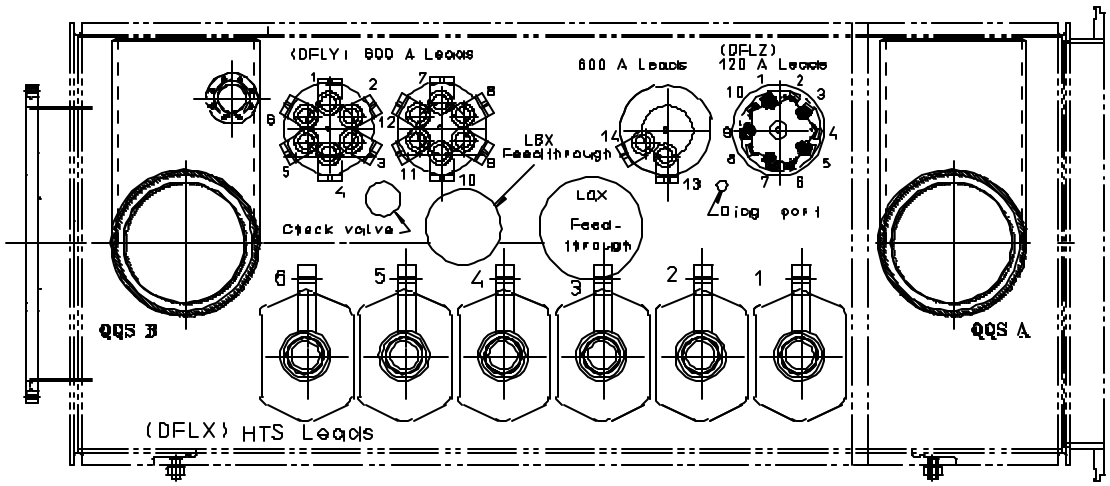


Figure 4.2.2-2. Location of LQX and LBX Instrumentation Feedthrough Assemblies for DFBXC and DFBXG. The LQX assembly is located at y = - 1150 and the LBX assembly is located at y = -1440.

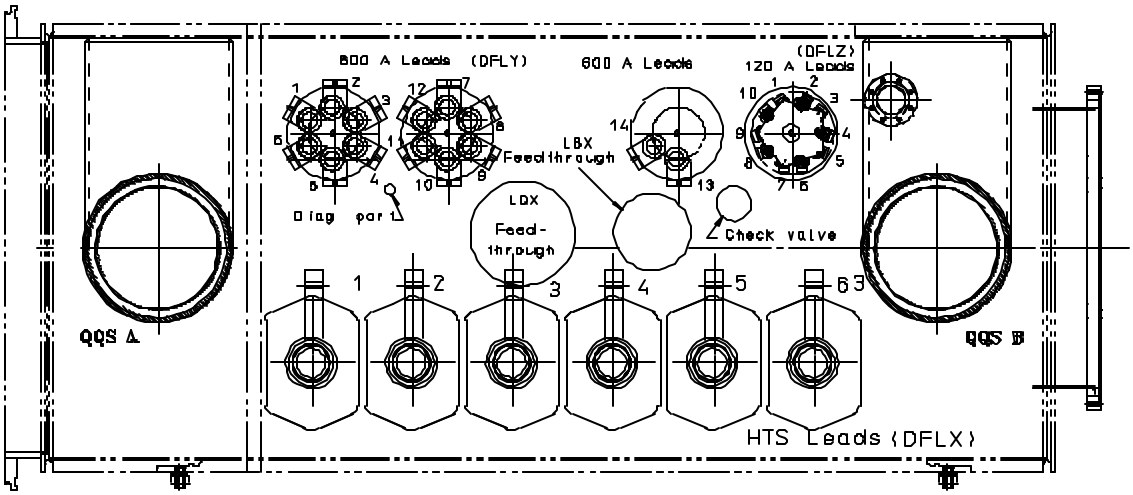


Figure 4.2.2-3. Location of LQX and LBX Instrumentation Feedthrough Assemblies for DFBXD and DFBXH. The LQX assembly is located at y = + 1150 and the LBX assembly is located at y = +1440.

The individual feedthroughs are Ceramaseal P/N 4275-21-W which have a 12 kV voltage rating and an internal pressure rating of 68 bar. Air-side plugs, Ceramasseal P/N 14419-01-A are used to connect to the LHC control system.

The Ceramaseal feedthroughs are arranged in a pair of arrays, each with 7 pins, as shown on Figure 4.2.2-1, for a total of 14 pins.

Each feedthrough is uniquely identified by an alphanumeric designator. The array position is denoted by a letter (M or N) which is permanently marked on the housing, and each feedthough position is the array is denoted by a number (1-7) which is permanently marked on the array.

The thermometer wires are terminated in a Ceramaseal Receptacle P/N 16013-02-W. This receptacle has 19 pins with a voltage rating of 1 kV pin to pin and pin to body. The pressure rating is 500 psi (34 bar). An air-side plug, Ceramaseal P/N 16060-04-A is provided for connection to the LHC control system.

In addition to the electrical feedthroughs, the assembly contains two mechanical ports with male VCR-style Cajon connectors, P/N SS-8-VCR-1-6, that can be used as pressure taps for the LBX cold mass via the void fraction of the MBX2 tube.

The sections below present the details of the individual connectors.

4.2.2.1 LBX VOLTAGE TAPS

The LBX magnet has 6 voltage tap wires (designated here as MBn) [6]. These wires are individually soldered to the Ceramaseal feedthroughs, P/N 4275-21-W. The connection is potted with de-aired Stycast 2850MT (blue) epoxy on the helium side to provide voltage holding capability and strain relief for the wires. Air-side plugs, Ceramaseal P/N 14419-01-A, are used to connect the individual feedthroughs to a cable receptacle, Fischer K 105 A054. The cable receptacle is the interface point with the LHC control system. Table 4.2.2.1-1 gives the correspondence between magnet voltage tap, feedthrough number, and cable receptacle pin designation.

Table 4.2.2.1-1. Location of LBX Voltage Tap Signals

LBX Signal Wire	Feedthrough Number[a]	Cable Receptacle Pin
MB1	M-1	2
MB2	M-2	3
MB3	M-3	4
MB4	M-5	5
MB5	M-6	6
MB6	M-7	7

a. M-4 is used below for a warmup heater lead.

4.2.2.2 LBX HEATERS

There are 4 wires for quench protection heaters (designated here as QHn) and 4 wires for warmup heaters (designated here as WHn)[6]. The individual feedthroughs have a current rating of 30 A, which are more than sufficient to power the heaters. Air-side plugs, Ceramaseal P/N 14419-01-A, are used to connect the individual feedthroughs to a cable receptacles that serve as the interface point with the LHC control system. The quench protection heater leads are terminated in a single 4-pin cable receptacle,

Fischer K 105 Z053, and the warmup heater leads are terminated in a pair of 2-pin cable receptacles, Fischer K 105 Z051. Table 4.2.2.1-1 gives the correspondence between heater lead, feedthrough number, and cable receptacle pin designation.

Table 4.2.2.2-1 gives the pin locations of the LBX heaters.

Table 4.2.2.2-1. Location of LBX Heater Connections

LBX Heater Lead	Feedthrough Number	K 105 Z053 Receptacle Pin	K 105 Z051 Receptacle (1) Pin	K 105 Z051 Receptacle (2) Pin
WH1+	M-4		1	
WH1-	N-1		2	
WH2+	N-2			1
WH2-	N-3			2
QH1+	N-4	1		
QH1-	N-5	2		
QH2+	N-6	3		
QH2-	N-7	4		

4.2.2.3 LBX THERMOMETERS AND LIQUID INDICATORS

The LBX cold mass contains 2 thermometers and 2 liquid indicators [6], which require 16 wires. These wires are terminated in a 19-pin Ceramaseal receptacle P/N 16013-02-W as shown on Figure 4.2.2-1. The receptacle has a solder cup on the helium side and has a voltage rating of 1 kV pin to pin and pin to casing. The wires will be potted with de-aired Stycast 2850MT (blue) epoxy into the connector to provide additional voltage withstand capability and to provide strain relief. The receptacle pin connections are given in Table 4.2.2.3-1. An air-side plug, Ceramaseal P/N 16060-04-A with crrimp-type contacts is provided for connection to the CERN system.

Table 4.1.1.3-1. LBX multipin receptacle pin designations.

Thermometer	V+	V-	I+	I-
T1	1	2	3	4
T2	5	6	7	8
L1	9	10	11	12
L2	13	14	15	16

4.2.2.4 PRESSURE PORTS

The VCR-style pressure ports, item 5 in Fig 4.2.2-1, provide CERN a means of monitoring the pressure in the dipole cold mass.

4.2.3 DFLX SIGNALS

The connectors on the individual DFLX current leads are identical to those in section 4.1.2 above. However, at Points 2 and 8 there are a total of 3 pair of DFLX installed in the DFBX, compared with 2 pair at points 1 and 5.

4.2.3.1 DFLX VOLTAGE TAPS

The voltage tap connectors on the individual DFLX current leads are identical to those in section 4.1.2.1 above. However, at Points 2 and 8 there are a total of 3 pair of DFLX installed in the DFBX.

4.2.3.2 DFLX THERMOMETERS

The thermometer connectors on the individual DFLX current leads are identical to those in section 4.1.2.1 above. However, at Points 2 and 8 there are a total of 3 pair of DFLX installed in the DFBX.

4.2.4 DFLY VOLTAGE TAPS

The voltage tap arrangement for the 600 A vapor-cooled leads (DFLY) is identical to that in section 4.1.3.

4.2.5 DFLZ VOLTAGE TAPS

The voltage tap arrangement for the 120 A vapor-cooled leads (DFLZ) is identical to that in section 4.1.4.

4.2.6 DFBX SIGNALS

4.2.6.1 LIQUID HELIUM CHAMBER SIGNALS

The signal receptacle for the Liquid Helium Chamber signals is identical to that discusssed in 4.1.5.1.

4.2.6.2 CRYOGENIC PIPING SIGNALS

The signal receptacle for the Cryogenic piping signals at Points 2 and 8 is identical to that discusssed in 4.1.5.2.

4.2.6.3 1.9K OVERFLOW CHAMBER SIGNALS

The 1.9 K overflow chambers are passively heated so no active sensors and heaters are needed. However, provision is made for a pressure tap for CERN's use. The pressure tap access is surrounded by a helium guard volume. Items 17 and 14 on Figure 4.2.6.3-1 show the location of the 100 mm Conflat Flange and tube that form the base of the guard volume on the top plate for DFBXC (IP2L) and DFBXG (IP8L). The details of the pressure tap and helium guard volume are the same as described above in 4.1.5.3.

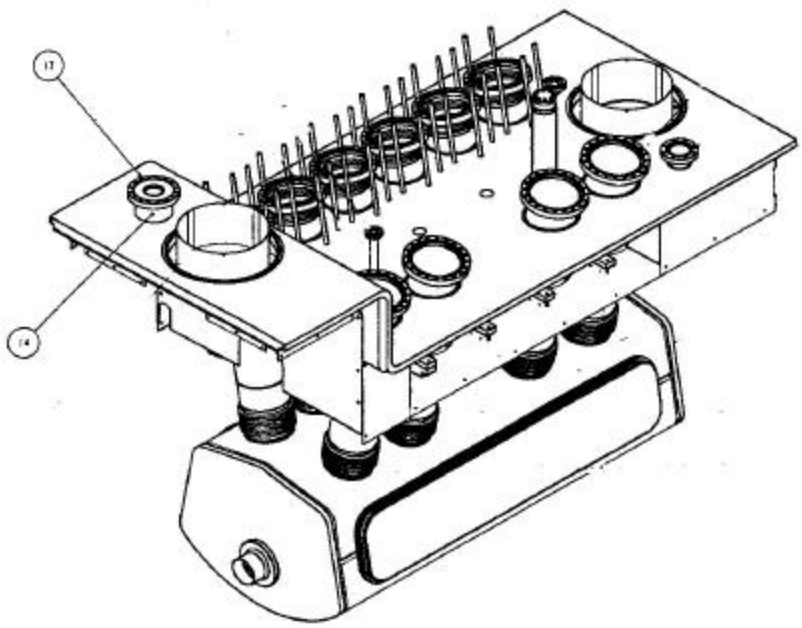


Figure 4.2.6.3-1. DFBXC and DFBXG Top Plate Assembly. Items 14 and 17 form the base of the helium guard volume.

5. INTERFACE MATERIALS

Table 5-1 lists the interface materials covered by this specification.

Table 5-1. Interface Materials

Major Assembly	Item	Quan[a].	Manufacturer/ Part Number	Description	Resp.
LQX Signals sections 4.1.1 & 4.2.1	2 kV 40-pin plugs for voltage taps and heaters	32	Fischer SF 107 A051	Non-locking panel plug, 27 pole, stainless steel body, PEEK contact block	LBNL
	1 kV air-side plug for low voltage sensors,	8	Ceramaseal 16060-05-A	MS-style plug, 32 pin, crimp connection	LBNL
	VCR Blind Female Nut,	16	Cajon SS-8-VCR-1-BL	Used to cap the male VCR connector (installed)	LBNL
	Gasket for Cajon connector	32	Cajon CU-8-VCR-2-GR	Copper gasket with retaining ring (not installed)	LBNL
	VCR Female Nut,	64	Cajon SS-8-VCR-1	Needed to make connection to CERN pressure sensor (not installed)	LBNL
	VCR Gland,	32	Cajon SS-8-VCR-3	Needed to make connection to CERN pressure sensor (not installed)	LBNL
DFLX Signals sections 4.1.2 & 4.2.3	Air-side plug for voltage taps,	80	Fischer S 104 A065	6-pin plug, solder connection, PEEK insulation	CERN
	Air-side plug for	40	Fischer	16-pin plug, solder	CERN

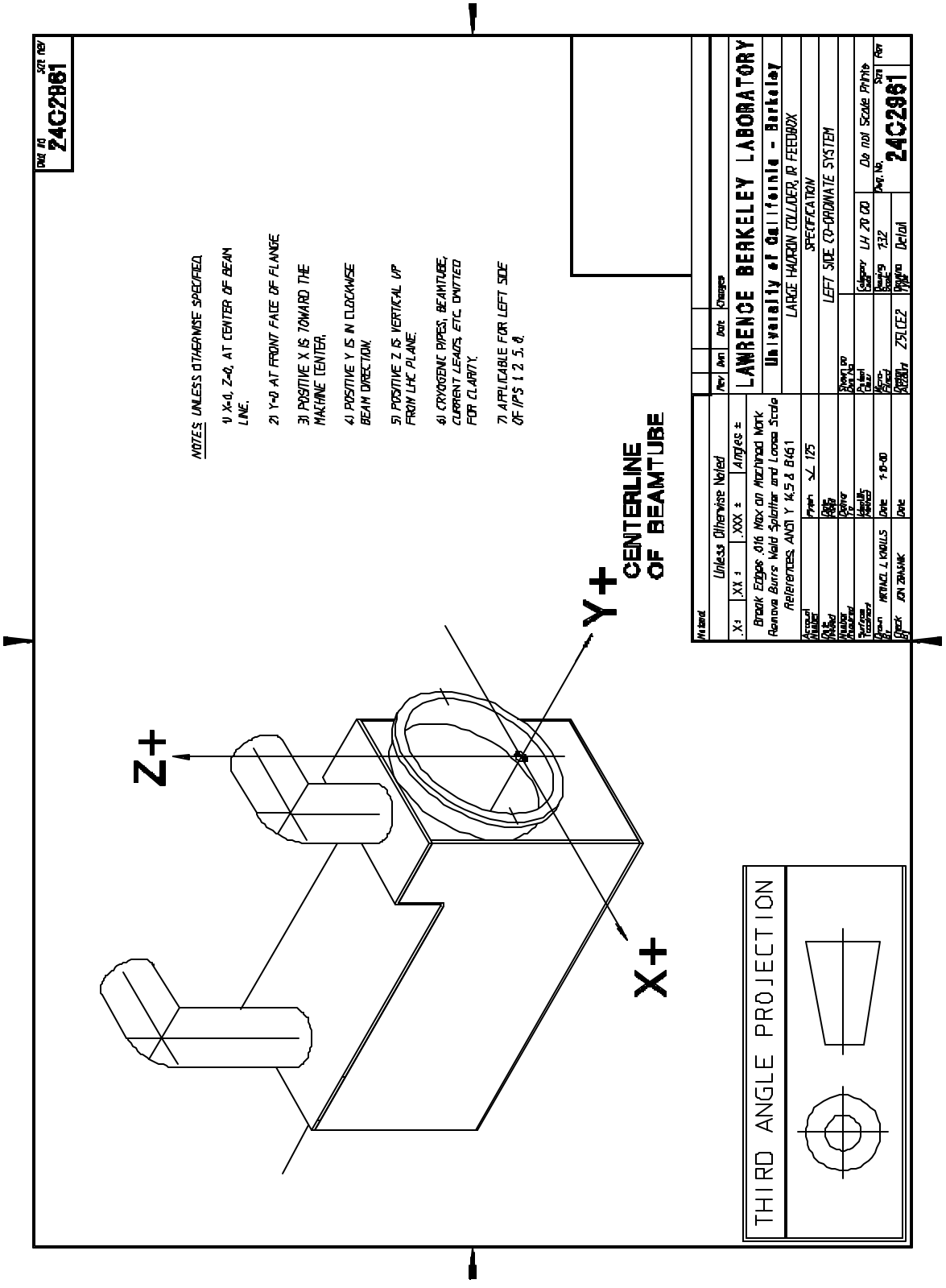
Major Assembly	Item	Quan[a].	Manufacturer/ Part Number	Description	Resp.
	Pt RTD's,		S 104 Z086	connection, PEEK insulation	
DFLY Signals sections 4.1.3 & 4.2.4	Air-side plug for voltage taps	24	Fischer S 107 A052	40-pin plug, solder connection, PEEK insulation	LBNL
DFLZ Signals, sections 4.1.4 & 4.2.5	Air-side plug for voltage taps	8	Fischer S 107 A052	40-pin plug, solder connection, PEEK insulation	LBNL
LBX Signals section 4.2.2	2 kV air-side plug for voltage taps	4	Fischer S 105 A054	7 pin plug, solder connection, PEEK insulation	CERN
	2 kV air-side plug for quench heaters	4	Fischer S 105 Z053	4 pin plug, solder connection, PEEK insulation	CERN
	2 kV air-side plug for warm up heaters	8	Fischer S 105 Z051	2 pin plug, solder connection, PEEK insulation	CERN
	1 kV air-side plug for low voltage sensors,	4	Ceramaseal 16060-04-A	MS-style plug, 19 pin, crimp connection	LBNL
	VCR Blind Female Nut,	8	Cajon SS-8-VCR-1-BL	Used to cap the male VCR connector (installed)	LBNL
	Gasket for Cajon connector	32	Cajon CU-8-VCR-2-GR	Copper gasket with retaining ring (not installed)	LBNL
	VCR Female Nut,	16	Cajon SS-8-VCR-1	Needed to make connection to CERN pressure sensor (not installed)	LBNL
	VCR Gland,	16	Cajon SS-8-VCR-3	Needed to make connection to CERN pressure sensor (not installed)	LBNL
DFBX Signals, sections 4.1.5 & 4.2.6	Air-side plug for Liquid Helium Chamber Signals	8	Fischer S 104 Z086	16-pin plug, solder connection, PEEK insulation	CERN
	VCR Blind Female Nut	16	Cajon SS-8-VCR-1-BL	Used to cap the male VCR connector (installed)	LBNL
	Gasket for Cajon connector	64	Cajon CU-8-VCR-2-GR	Copper gasket with retaining ring (not installed)	LBNL
	VCR Female Nut	32	Cajon SS-8-VCR-1	Needed to make connection to CERN pressure sensor (not installed)	LBNL
	VCR Gland	32	Cajon SS-8-VCR-3	Needed to make connection to CERN pressure sensor (not installed)	LBNL
	Air-side plug for Cryogenic Piping Signals	8	Ceramaseal 16060-05-A	MS-style plug, 32 pin, crimp connection	LBNL

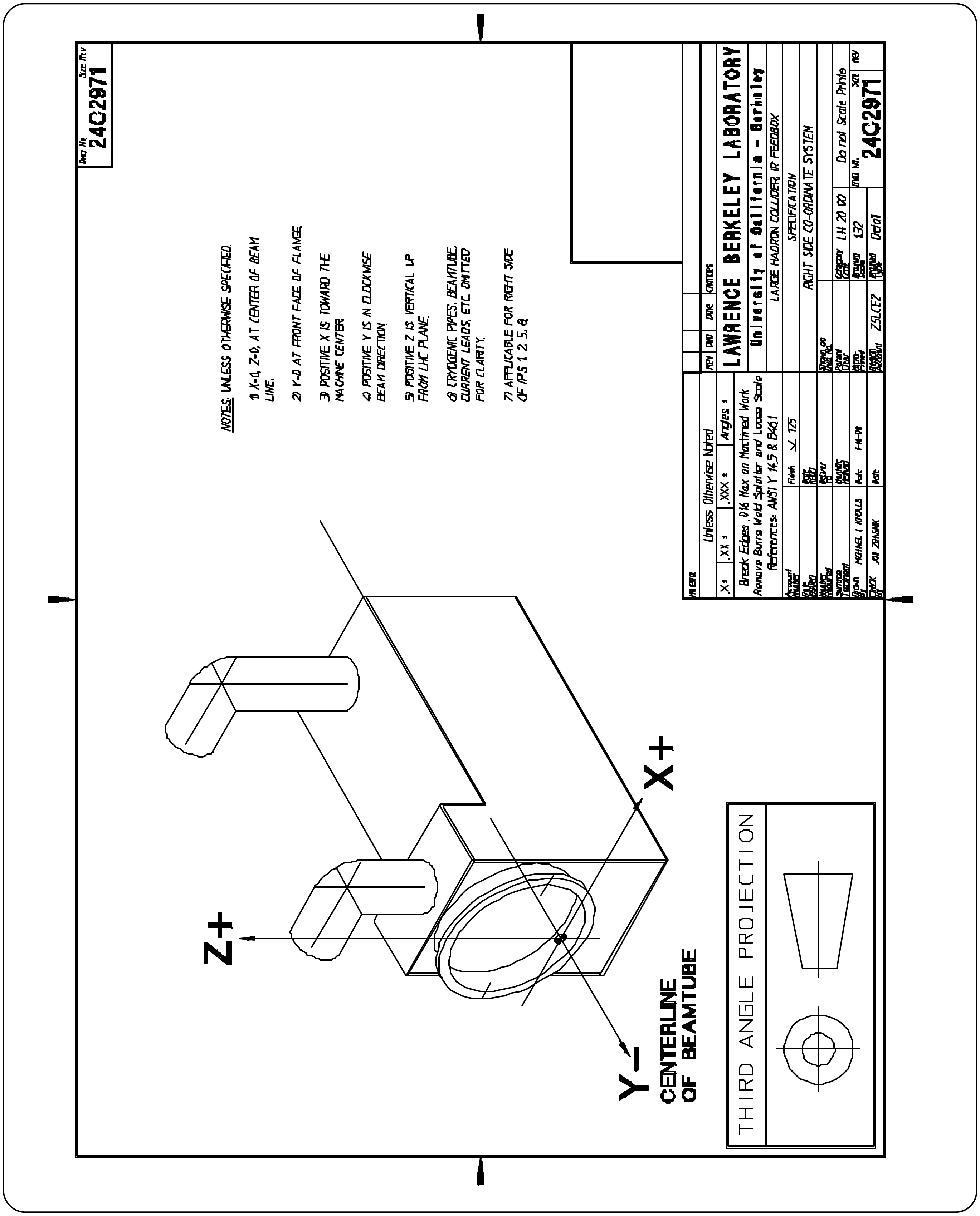
a. Quantity refers to the total required for all 8 DFBX.

6. REFERENCES

1. LHC Engineering Specification, “Inner Triplet Feedboxes General Interfaces”, LHC-DFBX-ES-0200.00 ver 1.0.
2. LHC Engineering Specification, “DFBX-LQXB Interface Specification”, LHC-DFBX-ES-0210 rev 1.1.
3. LHC Engineering Specification, “Instrumentation Wires, Connection Techniques and Feedthroughs for the LHC Cryomagnets and QRL”, LHC-QI-ES-0001 rev 1.0.
4. LBNL Engineering Specification, “7500 A Current Leads Using High Temperature Superconductor for the LHC Inner Triplet Magnets", M923B. (Will become LHC-DFLX-CA-0001).
5. LHC Engineering Specification, “DFBX-Power Converter Interfaces”, LHC-DFBX-ES-0250.
6. LHC Engineering Specification, “DFBX-LBX Interface Specification”, LHC-DFBX-ES-0230 rev 1.1.

7. APPENDIX A – DEFINITION OF DFBX LOCAL COORDINATES




24C2971
NOTES: UNLESS OTHERWISE SPECIFIED.
1) X=0, Z=0, AT CENTER OF BEAM LINE.
2) Y=0 AT FRONT FACE OF FLANGE.
3) POSITIVE X IS TOWARD THE MACHINE CENTER.
4) POSITIVE Y IS IN CLOCKWISE BEAM DIRECTION.
5) POSITIVE Z IS VERTICAL UP FROM LHC PLANE.
6) CRYOGENIC PIPES, BEAMTUBE, CURRENT LEADS, ETC. OMITTED FOR CLARITY.
7) APPLICABLE FOR RIGHT SIDE OF IPS 1 2 5 8
Z+
X+
Y-
CENTERLINE OF BEAMTUBE
THIRD ANGLE PROJECTION
Unless Otherwise Noted
Break Edges .016 Max on Machined Work
Remove Burrs Weld Splatter and Loose Scale
References: ANSI Y 14.5 & B46.1
MICHAEL I. KNOLLS
ALI ZBASNIK
LAWRENCE BERKELEY LABORATORY
University of California - Berkeley
LARGE HADRON COLLIDER, IR FEEDBOX
SPECIFICATION
RIGHT SIDE CO-ORDINATE SYSTEM
LH 20 00
1:32
Detail
Z5LCE2
Do not Scale Prints
24C2971